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WAR PROBLEMS IN MATHEMATICS.

By William E. Breckenridge.

In the preparation of this paper the author was assisted by Murray K. Aronson, Mary Baxter, R. P. Bliss, Morris Cohen, Mary Fowler, Earnest Greenwood, Marie L. Guinée, Lena M. Keeler, H. F. MacNeish, L. S. Odell, Anna M. Ohlssen, A. Lila Pratt, Jeannette Romaine, Earl S. Russell, Frank C. Touton, Earnest Townsend, Agnes L. Waring, students in Teachers College.

The drawings were made by M. C. Henriques.

This collection of problems has for its purpose the teaching of patriotism in the mathematics classroom. It aims to suggest to teachers of mathematics in colleges, high schools, junior high schools, and the upper grades of elementary schools types of war problems that may be used in the mathematics class either as substitutes for the old familiar problems or as supplementary illustrative material. In the discussion of these problems there will be presented excellent opportunities for the teacher to interest his students in some of the splendid efforts of our country and our allies to win the war, thereby inspiring these students with zeal for patriotic service.

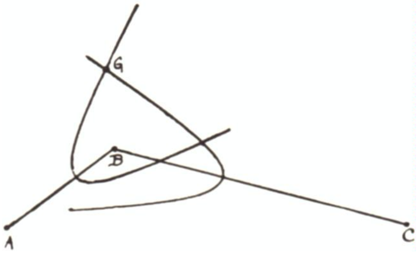

Fig. 1.

The material is suggestive rather than exhaustive. Many good problems that were contributed have been omitted on account of lack of space. Special mention should be made of Mr. H. F. MacNeish, whose experience in the Yale R. O. T. C. enabled him to contribute many valuable problems.

1. *Locating the German Super-Gun.* (The following method was actually used.) *A, B* and *C* are three observation stations equipped with chronometers registering time accurately to one tenth of a second. The distance $AB = 1{,}000$ ft., $BC = 3{,}000$ ft. Station *A* records the report of the gun 0.6 second later than *B*. How much nearer to *B* than to *A* is the gun located? What is the locus of all possible positions of the gun? (One branch of a hyperbola adjacent to *B* with foci at *A* and *B*.) Station *C* records the report of the same gun 2.4 seconds later than station *B*. How much nearer to *B* than to *C* is the gun? What is the locus of all possible positions of the gun? (One branch of a hyperbola adjacent to *B* with foci at *B* and *C*.) Locate the gun graphically at the intersection of these two foci.

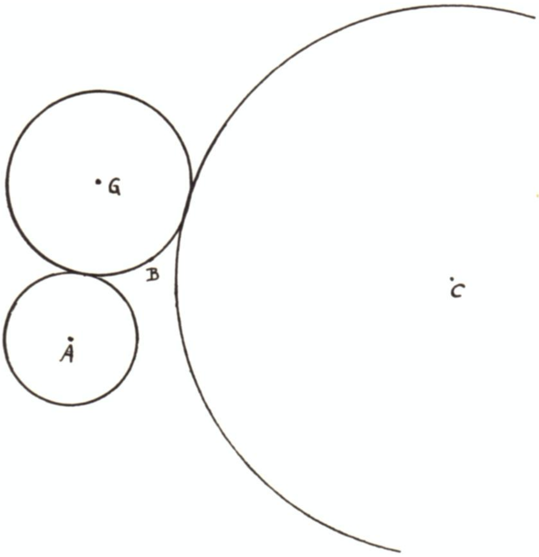

Fig. 2.

2. The problem of locating the super-gun may be solved by elementary geometry.

Assume that sound travels 1,000 ft. per second. Taking as large a scale as possible, draw a circle with *A* as a center and a radius of 600 ft. With *C* as a center and a radius of 2,400 ft., draw another circle. Through *B* draw the circumference of a circle tangent to circles *A* and *C*. The center of this circle will be the position of the super-gun.

It is possible to draw this circle by elementary geometry, but a more practical method is to locate the center of the circle by trial, using a very large scale.

3. The same problem may be stated more simply as follows: Three listening stations, *A, B* and *C,* are established near the front line. *B* is equipped with a listening device and an electric connection with stop watches located at *A* and *C*. When the sound of the gun is heard at *B,* the observer presses an electric button, starting stop watches at *A* and *C*. When the observers at *A* and *C* hear the report of the gun, they observe the time that has elapsed since their watches were started. Suppose 2 seconds have elapsed at *A* and 3 seconds at C. Sound travels approximately 1,000 ft. per second, but the velocity could be determined as accurately as possible under the conditions at the time of the observations. Then *A* is 2,000 ft. farther from the gun than *B,* and *C* is 3,000 ft. farther from the gun than *B*. Draw a circle with *A* as a center and 2,000 ft. as a radius. Draw another circle with *C* as a center and 3,000 ft. as a radius. Draw a circle whose circumference shall pass through *B* and which shall be tangent to the circles *A* and *C*. The center of the circle is the required location of the super-gun.

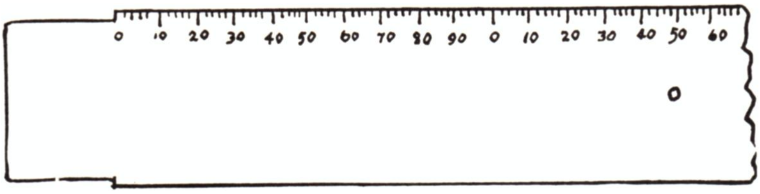

FIG. 3.
Battery Commander's Ruler, Left Half, exact size.

The B. C. Ruler is a ruler about 6 in. long with a hole at the middle graduation through which runs a string long enough to reach from the ruler to the observer's teeth when the ruler is held at arm's length. As used at the Yale R. O. T. C., the ruler is calibrated so that when the knot on one end of the string is held in the teeth, the six inches of the scale subtends 300 mils. The string is then about 20 in. from the ruler and the graduations on the ruler are numbered as indicated in Fig. 3. To check the calibration of the ruler, a convenient distance of perhaps 100 ft., is measured and a rod 10 ft. high as *TT′* is noted. The observer holds the ruler vertically so that the line of sight from his eye, *E*, to *T*, the lower end of the object, intersects the ruler at its midpoint. He then notes the point *D* on the ruler where his line of sight to *T′* intersects the ruler. The distance *CD* on the ruler is called 100 mils since it subtends an angle of 100 mils. One hundredth of *CD* is therefore 1 mil. A mil is the angle whose tangent is 0.001, *i. e.*, the angle subtended by 1 ft. at a distance of 1,000 ft. It is approximately $1/6400$ of 360°.

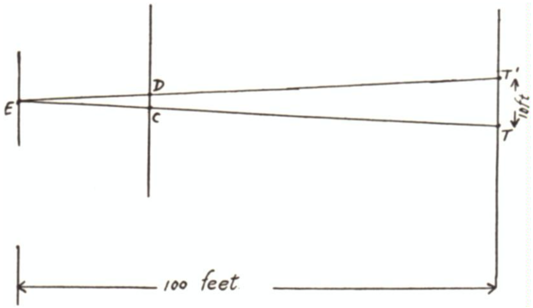

Fig. 4.

A simple mil rule may be made as follows: To one end of any 6-in strip of wood or a lead pencil attach a string 20 in. long with a knot at the end of the string. Mark off the strip of wood into inches. Every inch will be 50 mils. Subdivide the inch into as small divisions as are practical. Transparent celluloid may be used to make a very good ruler.

If $R =$ the range in yards,
$W =$ the width or height of an object in yards at the distance of the range,
$M =$ the number of mils subtended by W,

then, evidently, $\mathrm{R} = \frac{W}{M} \times 1{,}000$.

4. Prove this formula by similar triangles.

Estimation of Range by the B. C. Ruler.

5. A certain tree is estimated to be 15 yd. high. It covers an angle of 25 mils on the B. C. Ruler. How far away is it?

$$R = \frac{W}{M} \times 1{,}000$$

$$= \tfrac{15}{25} \times 1{,}000$$

$$= 600.$$

6. The telegraph poles seen on a distant railway running at right angles to our line of sight are known to be 44 yd. apart. The distance between two adjacent poles subtended 40 mils on the B. C. Ruler. Find the range to the railway.

$$R = \tfrac{44}{40} \times 1{,}000$$

$$= 1{,}100.$$

7. A line of skirmishers at about 1 yd. per man apart covers 40 mils on the B. C. Ruler. The range is known to be 800 yd. Find the number of men.

$$W = \frac{RM}{1{,}000}$$

$$= \frac{800 \times 40}{1{,}000}$$

$$= 32.$$

Hence there are 33 men, one more than the number of spaces.

8. A column of infantry in fours is seen by a patrol at 1,200 yd. range. It is moving across he patrol's front and covers 120 mils on the B. C. Ruler from the head to the rear of the column. Assuming that the men are 1 yd. apart, how many men are in the column?

$$W = \frac{RM}{1{,}000}$$

$$= \frac{1{,}200 \times 120}{1{,}000}$$

$$= 144.$$

Hence the number of men in a line is 145 and in four lines $4 \times 145 = 580$.

9. From a certain point a section of a hostile trench measures 150 mils. A scout goes forward 330 paces and finds that the trench covers 200 mils. If a pace is counted as 1 yd., find the range from the first point to the trench.

$$R = \frac{W}{M} 1{,}000$$

and

$$R' = \frac{W}{M'} 1{,}000.$$

Hence

$$\frac{R}{R'} = \frac{M'}{M}.$$

By division

$$\frac{R}{R - R'} = \frac{M'}{M' - M}.$$

Hence

$$R = \frac{M'(R - R')}{M' - M}.$$

Applying this formula,

$$R = \frac{200 \times 330}{200 - 150}$$

$$= 1{,}320.$$

10. When the distance is paced away from the trench, find the formula for R, and make up problems under this formula.

11. We have come to a river bank, and a village at some distance across the river covers 150 mils. An observer walks back 200 yd., keeping our party on the bank in line with the village, and finds that at that point the village covers 120 mils. Find the distance from our position on the river bank to the village.

12. From the New Jersey shore of the Hudson River at Fort Lee Ferry, 4 freight cars on the New York shore subtend an angle of 40 mils. If a freight car is approximately 40 ft. long, find the width of the Hudson River at this point.

13. An artillery officer wishes to station a gun on a north-and-south road so as to fire to best advantage on a column of infantry 600 yd. long stationed on an east-and-west road. The front of the column is 200 yd. from the intersection of the two roads. Show that when CG is tangent to the circle through GAB, the angle AGB is greater than any other angle such as $AG'B$, since the angle AGB is measured by ½ arc AB and the angle $AG'B$ is measured by $\frac{1}{2}(AB - AE)$.

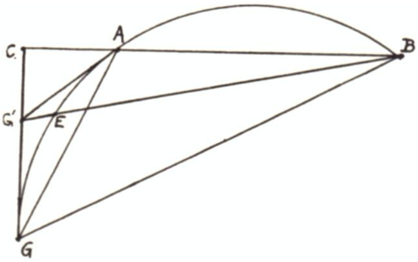

FIG. 5.

14. Also

$$\overline{CG}^2 = CA \times CB,$$
$$= 200 \times 800,$$
$$= 160{,}000,$$

and

$$CG = 400.$$

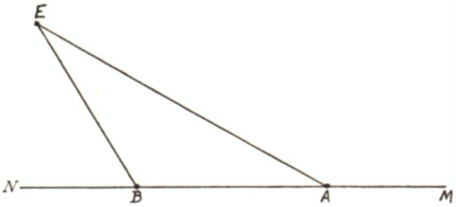

FIG. 6.

15. A battery is advancing along a road MN while attacking the enemy at position E. At position A, the angle EAN is measured with the B. C. Ruler. The battery continues to advance to the position B where the angle $EBN = 2$ angle EAN. Show that the range BE is equal to the known distance AB.

16. Two batteries of artillery situated 600 yd. apart in a second-line trench move their guns forward 100 yd. and 200

yd. respectively. Locate a common ammunition dump in the second-line trench to the most advantage with respect to distance. Producing *B'A'* its own length to *E* and drawing *BE* intersecting *AA'* in *D,* we have *D,* the point required. Show that $BD + DB' <$ any other distance as $BD' + D'B'$. Show that the numerical value of *AD* is 400 yd.

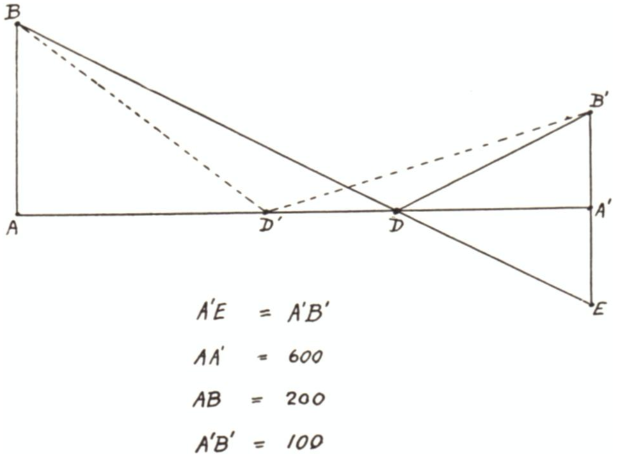

FIG. 7.

17. *Making Range Tables for Big Guns.*—For a brief, but

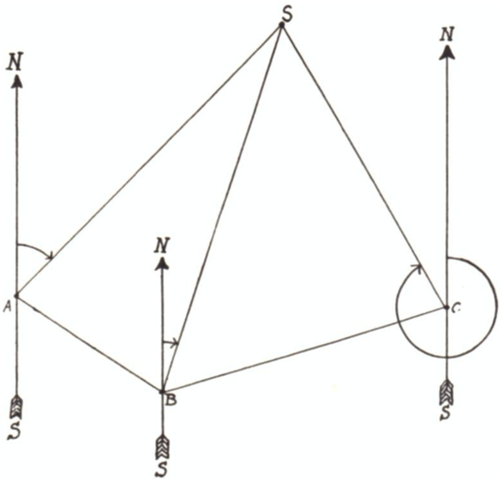

FIG. 8.

excellent description of the mathematics of artillery, see the article by Mr. J. Malcolm Bird on "The Mathematics of Warfare" in THE MATHEMATICS TEACHER, September, 1917. At the Sandy Hook Proving Grounds and at Aberdeen the range tables are corrected by actual results observed when a gun is fired. Computations involve the use of trigonometry and the slide rule. The text-book used by the Yale R. O. T. C. contains much material for problems in mathematics. Send to the Yale University Press, New Haven, Conn., for Notes on Training Field Artillery Details by Danford and Moretti. The B. C. Ruler may be obtained at the same address.

Observation towers are located at *A, B* and *C* in the vicinity of the emplacement of the gun to be tested. *NS* represents a north-and-south line. *S* is the position of the splash made by the shell from the gun. *AB, AC* and *BC* are known distances. When the splash occurs, the observers at *A, B* and *C* take the angles *NAS, NBS* and *NCS,* measured clockwise and called the

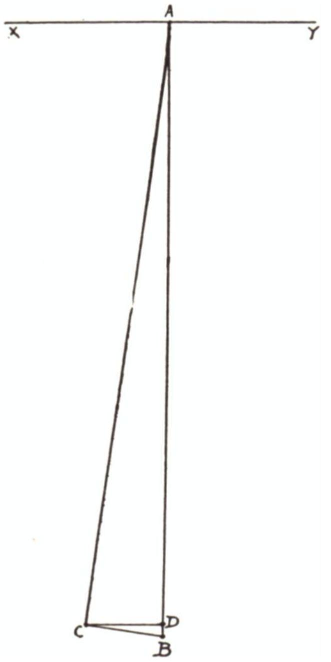

FIG. 9.

azimuth of the splash. Three stations are used in case one observer fails to get the angle and as a check on the other observations. Problems based on the above figure are easily made up by assuming angles and distances.

Range Finding by Geometry. (Used by scouts in the U. S. Army.) See Fig. 9.

18. Scouts on the line CD see the enemy on the line XY. One man stands at D, another walks back along line DB, while a third walks to the left at right angles to AB for a convenient distance as CD. By means of the optical square (or a forester's mirror) the right angle ACB is observed and the observer walking along DB is signalled to stop at B. CD and DB are measured. Hence,

$$AD = \frac{\overline{CD}^2}{DB}\,.$$

If CD is 80 yd. and DB is 10 yd. show that $AD = 640$ yd.

19. *Visibility of the Periscope of a Submarine.*—Show that the distance in miles at which a periscope may be seen from an observation station on a ship h ft. high is approximately $\sqrt{3h/2}$.

20. What must be the altitude above sea level in order that the periscope of a submarine (considered as at the surface of the water) may be visible 8 mi. away. (Assume the diameter of the earth as 8,000 mi.)

21. At a distance of 50 ft. above sea level, at what distance is a periscope visible, if it extends 6 ft. above the surface of the water?

22. *Laying Out a War Garden.*—Fig. 10 will suggest an instrument for laying out a right angle in a war garden. Why is the angle C a right angle? What other dimensions could be used?

23. A camp site is roughly in the shape of a triangle whose sids are 1½ mi., 1¾ mi. and 1¼ mi. Find the number of acres included in the tract.

24. An army camp site is bounded by two roads parallel to each other and 1¼ mi. apart. The camp extends along one of them 1 mi. and along the other 1¾ mi. The other two sides are straight roads 1⅜ mi. and 1⅝ mi. Find the area of the

camp and the length of a road parallel to the first two and midway between them.

25. The floor area of the barracks erected at a camp was found to be too small; so it was decided to construct a new building similar in shape but having a floor area 50 per cent. greater. If the first building was 60 ft. by 25 ft., find the dimensions of the second.

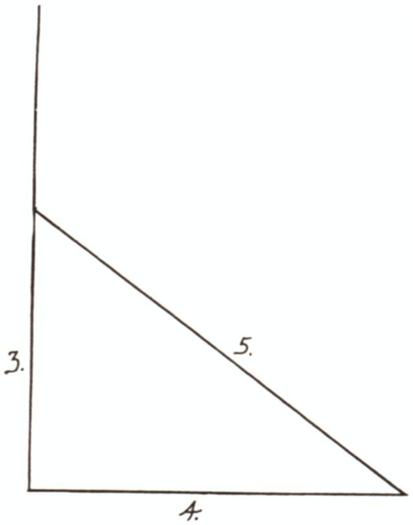

Fig. 10.

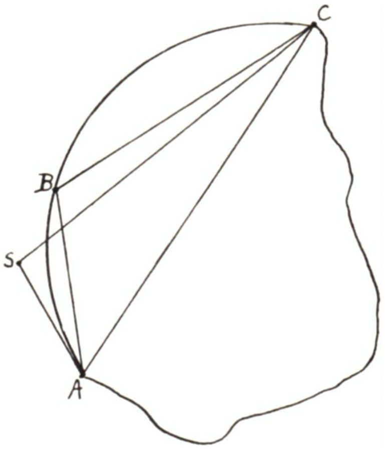

Fig. 11.

26. It is known that a certain harbor and entrance have been mined within a section determined by the circular arc shown. Show that a ship is safe as long as the angle S is less than the angle ABC. (Fig. 11.)

27. Represent graphically the weekly contributions of a school War Savings Society listed below:

Feb. 11, 1918	$11.88	Feb. 18, 1918	$14.53
" 25, "	15.40	Mar. 4, "	11.29
Mar. 11, "	14.13	" 18, "	11.04
" 25, "	20.55	Apr. 1, "	Vacation
Apr. 8, "	22.15	" 15 "	$14.18

28. *War Substitutes.*—Make a graph showing the percentage composition of foods given in the table below, representing the

proteid by a dotted line and the carbohydrates by a continuous line. Approximately how many pounds of potatoes do we need to substitute for one pound of wheat?

Is there any loss of carbohydrates by substituting 1 lb. of corn meal for 1 lb. of wheat?

	Per Cent. Proteid.	Per Cent. Carbohydrates.
Flour (white)	11.4	75.1
Flour (entire)	13.8	71.9
Corn meal	9.2	75.4
Rice	7.8	79.0
Potatoes	2.2	18.4
Oatmeal	16.1	67.5
Rye flour	6.8	78.7
Barley meal and flour...............	10.5	72.8

29. An army cook wishes to prepare a meal that will contain 8 per cent fat. He is going to use beef containing 6 per cent fat per pound and beans 3 per cent fat per pound. If he must prepare 50 lb. of food, how many pounds of beef must he use and how many pounds of beans?

30. The government desires to buy wheat from a certain dealer. This man shows two different samples of spring wheat, selling at $2.05 and $2.25 per bushel respectively. If the government then decides to buy 12,000,000 bushels at $2.10 a bushel, to be made up of the two kinds, how many bushels of each kind must be taken?

31. In preparing the soil for corn, a fertilizer containing 11 parts phosphoric acid, 12 parts nitrogen and 2 parts potash is used. How many pounds of each will be needed to make a ton of fertilizer?

32. A messenger with sealed orders is sent forward to a station 250 mi. distant. He travels at the rate of 20 mi. per hour. Thirty minutes later the orders are changed, and a second man starts out who travels at the rate of 35 mi. per hour. Where and when will be overtake the first man?

33. One girl scout sold 100 Thrift Stamps in three days, another girl scout sold the same number of stamps in four days. At the same rate how long will it take them both to sell 100 stamps?

34. In a certain meeting of the local Chapter of the Red Cross

with 48 members present, a motion was carried by a majority of 18. How many voted for the motion and how many against it?

35. The new American destroyers will make 35 knots an hour. In what time will a new destroyer overhaul a German submarine sighted at 3 mi. distant, if the submarine can travel only 15 knots on the surface?

36. The time of fall of a bomb, when the height at which it is dropped is known, is given by the following formula:

$$T = \frac{\sqrt{H}}{4} + \frac{H}{9{,}000},$$

where T is the time in seconds and H is the height in feet.

If a machine is flying at the height of 9,000 ft., what will be the time of the fall.

37. The distance a bomb travels forward:

$$D = \left[\left(\frac{\sqrt{H}}{4} + \frac{H}{9{,}000}\right) \times \begin{matrix}\text{Speed of machine}\\ \text{in feet per second}\end{matrix} - \frac{H}{40}\right]$$

$D =$ distance in feet,

$H =$ height in feet.

A machine is at a height of 18,000 ft., and its speed is 100 ft. per sec. Find the distance the bomb travels forward from the moment of release to the time of striking the ground.

38. At what height is a machine from which a bomb dropped to the ground will travel forward a distance of 2,500 ft., the speed of the machine being 110 ft. per sec.?

39. At 40 cts. a day for every soldier how long could the 700 million dollars which the United States people waste in food products every year supply a regiment of 2,000 soldiers? Give the answer in years and months.

40. If the box of an army truck is 6 ft. long. 5 ft. wide and 2 ft. high, how many cubic yards of sand would it hold when completely filled?

41. What is the longest stick that would just go in from one corner to an opposite one of the above box?

42. An army truck runs about 8 mi. to a gallon of gasoline. If gasoline costs 25 cts. a gallon, how much would it cost for a trip of 116 mi.?

43. If a mess sergeant is allowed 50 cts. a day for every soldier in his mess and he spends only 46 cts. a day for each of 52 men for 6 days, how much extra would he have to spend on a Sunday dinner for the whole mess?

44. A train of 30 army trucks runs from Buffalo to New York, a distance of about 447 mi. Suppose they make 90 mi. a day. The gasoline consumption averages 9 mi. per gallon at 25 cts. a gallon, and the oil averages a gallon at 50 cts. for each 120 mi. Two soldiers ride on every truck and they are allowed $2.50 each for every day they are on the trip. How much would the whole trip cost?

45. If wool for knitting socks costs $3.25 a pound and it takes 5 oz. for a pair of socks, how much will the wool cost for 6 pairs of socks?

46. Find the difference in income for 10 yrs. from $500 invested in a savings bank paying 4 per cent. interest and the same amount invested in bonds of the Third Liberty Loan at 4¼ per cent. interest. In each case the interest payments are put in the bank every 6 mo. and draw interest at 4 per cent.

47. A certain insurance company offered to sell $1,000 bonds of the Third Liberty Loan bearing interest at 4¼ per cent. for 10 semi-annual payments of $100 each and in the meantime insure the buyer for $1,000. If the company kept all of the interest coupons, what rate of interest did the company get on its investment?

48. How much money invested in U. S. bonds of the Third Liberty Loan at 4¼ per cent. will give the same return as $850 invested in the first loan at 3½ per cent.?

49. Two thousand boys left the New York City high schools to work on farms last summer for five months. They received $3.75 a week for the first four weeks, $5 a week for the next four weeks and $6.25 a week for the next four weeks, etc. Find every boy's weekly wage at the end of the summer, his total receipts for the summer, and the amount earned by the 2,000 boys during the five months.

50. The French army is using at the present time a type of trench digger that cuts a trench 10 ft. deep, 3 ft. wide and 500 ft. long in an hour. Assuming that it takes the same time for a trench 20 ft. deep but half as long, how long a time will it take to dig a 20-ft. trench 2,000 ft. long?

51. How many machines would have to be used to dig two 10-ft. trenches on a 10-mile front in one night of nine hours?

52. How much material in cubic yards is removed in going 16,000 ft.?

53. What is the height of the mound of earth thrown up if it spreads over only 6 ft. of ground and takes the mean position of a triangular cross-section? If it takes the form of a semicircle? Banked up to form a quadrant?

54. How long must the trench periscope be for a trench 20 ft. deep with earth thrown out so that the cross-section is an equilateral triangle with a base of 8 ft.?

55. A man buys "Ex steamer" 1,000 bbls. of currants for $44,500. This includes 1 per cent. commission, 8 per cent. marine and war insurance, and 110 shillings per ton freight. Besides this he pays ½ per cent duty; 45 cts. on a barrel storage per month and 1 per cent storage insurance. (*a*) For what must he sell the currants per bbl. to the retailer to make 33⅓ per cent profit net? (steamer's tonnage = 2,240 bbls.). (*b*) If a bbl. weighs 300 lb., for what must the retailer sell the goods per pound to make the same net profit?

56. It is estimated that it requires one workman per ton per month to build a ship. How many workmen were engaged in 1917 to build the output of 800,000 tons?

57. How many men will be required to build 5 million tons of shipping per year called for by the Shipping Board if the men speed up 10 per cent?

58. If a factory turns out 250 guns a day and 2 tanks a week, how long will it take to turn out 50 tanks, at the same time making guns, providing the force is increased 2½ times?

59. How many boats will it take to make a pontoon bridge over a river 295 ft. wide if 5 boats are used every 25 ft.? In what time could the bridge be erected if it takes three minutes to fix two boats?

60. What is the cost per hour of a 16-candle power electric light when by the daylight saving law, 8 lights burning on an average of three instead of four hours every evening, there is a saving of 28 cts. per week?

61. *Proteid Values.*

1 pound cheese = 1.27 pounds sirloin.
(cottage) = 1.09 round steak.
= 1.52 chicken.
= 1.44 smoked ham.
= 1.31 leg of lamb.
= 1.37 breast of veal.

In your section of the country find the cost of the above articles of food.

Find the cost of the meat equivalent to one pound of cheese.

How much is saved in using cheese and what per cent.?

62. The volume of a submarine boat is 4.5 cubic meters and the weight of the hull and its contents is 4,150 kg. What volume of water will have to be taken into the boat to sink it?

63. When the Germans invaded Belgium the Belgians managed to run 1,900 engines over the border into France. Of these 800 were rusted and beyond repair. The rest were repaired and turned over to the army for service. What per cent were serviceable?

64. Find how many ounces of pork and how many ounces of bread would be necessary for a standard ration (4 oz. fat. and 4 oz. proteid) if pork is 25 per cent fat and 12 per cent protein and bread is 1 per cent fat and 9 per cent protein?

Many such problems can be made up from any food table.

65. If whenever you cast on 72 stitches for a sweater, you bind off 18 stitches for the neck, how many would you bind off if you had used smaller needles and cast on 84 stitches?

66. Two airplanes starting at the same time from the same aviation field fly in direct lines that form an angle of 30° ; one flies at 35 mi. an hour, the other at 70 mi. an hour. How far apart will they be at the end of 15 min.?

67. Two towns, *A* and *B*, are 70 mi. apart and are connected by a road. A French army is situated in a moor 80 mi. from *A* and 55 mi. from *B*. Find the shortest direct distance that this army can take to reach the road *AB*.

68. A division marches 12 mi., turns through 60° to its left, goes 4 mi., turns through 90° to its left and marches ½ mi. farther. How far is it from the starting point?

69. Two roads branch at *A*. They make an angle of 70°

One division marches 6 mi. from A along one road, another marches 8 mi. from A along the other road. How far are the two divisions from each other?

70. From two points, A and B, on a line of earthworks, the bearings of a German Battery are respectively N. 16° E. and due north. If B is east-southeast of A and 2,000 yd. from A, find the distance of the gun from A.

71. Find the amount of $412 in five years' interest compounded quarterly a 4 per cent per annum.

72. Find the amount which should be paid for a $5 note due in 5 years, interest compounded quarterly at 4 per cent per annum.

73. Determine the dimensions of a cylindric can for canned vegetables so that the amount of tin used shall be a minimum and the can shall hold a quart.

74. Determine the minimum amount of seams to be soldered for the above can, assuming that the two circular edges and one lateral seam are soldered.

75. Combine the two and determine the most economical can, assuming cost of tin and solder. The time element of labor might be included.

76. Determine the minimum dimensions for a rectangular parallelopiped container that shall have a volume of 150 cu. in.

77. Determine the ratio of the length to the diameter of the cans so that they can be most economically packed in a given packing case.

78. How much railroad equipment is needed to move an army?

A statement prepared by Lieut. Col. Chauncey B. Baker, of the Quartermaster corps, U. S. A., and distributed to the railroads of the country by the Special Committee on National Defense of the American Railway Association is as follows: To move one field army of 80,000 men, consisting of three infantry divisions, one cavalry division, and a brigade, technically known as a brigade of field army troops—troops auxiliary to the infantry and cavalry divisions—requires a total of 6,229 cars made up into 366 trains with as many locomotives. These 6,229 cars would be made up of 2,115 passenger cars, 385 baggage, 1,055 box, 1,899 stock, and 775 flat cars. This quantity of equipment represents .7 of 1 per cent of the locomotives owned by American railroads, 4.2 per cent of their passenger cars and 0.2 of 1 per cent of their freight equipment.

The railroad equipment required to move various organizations of the army at war strength is as follows:

Infantry regiment, 55 officers, 1,890 men, 177 animals, 22 vehicles. Cars required, 48 passenger, 5 baggage, 15 box, 9 stock, 8 flat; total, 85 cars.

Cavalry regiment, 54 officers, 1,284 men, 1,436 animals, 26 vehicles. Cars required, 36 passenger, 8 baggage, 25 box, 72 stock, 9 open; total, 150 cars.

Artillery regiment, light, 45 officers, 1,170 men, 1,157 animals, 32 vehicles, 24 guns. Cars required, 32 passenger, 9 baggage, 25 box, 58 stock, 46 flat; total, 170 cars.

Artillery regiment, horse, 45 officers, 1,173 men, 1,571 animals, 35 vehicles, 24 guns. Cars required, 34 passenger, 10 baggage, 25 box, 78 stock, 47 flat; total, 194 cars.

Artillery regiment, mounted, 45 officers, 1,150 men, 1,229 animals, 24 guns. Cars required, 30 passengers, 7 baggage, 30 box, 61 stock; total, 124 cars.

Engineers. Pioneer Battalion, 16 officers, 502 men, 165 animals, 12 vehicles. Cars required, 14 passenger, 2 baggage, 10 box, 8 stock, 4 flat; total, 38 cars.

Signal Corps. Field Battalion, 9 officers, 171 men, 206 animals, 15 vehicles. Cars required, 6 passenger, 2 baggage, 5 box, 10 stock, 5 flat; total, 28 cars.

Any number of questions may be based upon these facts, *e. g.*, find the equipment owned by American railroads, remembering that passenger and baggage cars are classed as passenger cars; box, stock and flat cars as freight cars.

79. How Resources Indicate Victory. Graph Work.

COAL AND IRON. PERCENTAGE IN DIFFERENT COUNTRIES.
PRODUCTION, 1913.

	Percentages.		
	Coal.	Iron.	Steel.
United States	38	40	42
British Empire	26	14	12
France. Belgium, Italy	4	10	11
Germany. Austria-Hungary	25	27	28
All other countries	7	9	7

RESOURCES, 1913.

	Percentages.	
	Coal.	Iron Ore.
United States	52	63
British Empire	23	18
France, Belgium, Italy	1	2
Germany, Austria-Hungary	6	2
All other countries	18	15

PERCENTAGE OF OTHER RESOURCES, 1913.

	Petroleum.	Cotton.	Copper.	Timber.	Gold.	Wealth.	Railroads.	Ships.
United States	64	61	56	56	19	29	39	17
British Empire	2	24	11	4	63	18	18	42
France, Belgium, Italy				3		15	7	8
Germany, Austria-Hungary	2		3	11		19	10	11
All other countries	32	15	30	26	18	19	26	22

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